

FORM PTO-1390 (Modified)
(REV 11-98)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES

205739US6PCT

DESIGNATED/ELECTED OFFICE (DO/EO/US)

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

CONCERNING A FILING UNDER 35 U.S.C. 371

09/806990

INTERNATIONAL APPLICATION NO.

PCT/EP99/06962

INTERNATIONAL FILING DATE

21 September 1999

PRIORITY DATE CLAIMED

06 October 1998

TITLE OF INVENTION

SPARK GAP ARRANGEMENT

APPLICANT(S) FOR DO/EO/US

Peter HASSE, et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Request for Consideration of Documents Cited in International Search Report

Notice of Priority

Drawings (3 sheets)

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

09/806990

INTERNATIONAL APPLICATION NO.

PCT/EP99/06962

ATTORNEY'S DOCKET NUMBER

205739US6PCT

21. The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

- ☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1,000.00
- ☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00
- ☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00
- ☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00
- ☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =**CALCULATIONS PTO USE ONLY**

\$860.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).

\$130.00

| CLAIMS | NUMBER FILED | NUMBER EXTRA | RATE |
|--------------------|--------------|--------------|-----------|
| Total claims | - 20 = | 0 | x \$18.00 |
| Independent claims | - 3 = | 0 | x \$80.00 |

\$0.00

\$0.00

Multiple Dependent Claims (check if applicable). ☐

\$0.00

TOTAL OF ABOVE CALCULATIONS =

\$990.00

Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). ☐

\$0.00

SUBTOTAL =

\$990.00

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +

\$0.00

TOTAL NATIONAL FEE =

\$990.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). ☐

\$0.00

TOTAL FEES ENCLOSED =

\$990.00

Amount to be:

refunded

\$

charged

\$

☒ A check in the amount of \$990.00 to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees.

A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 15-0030 A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:



22850

Surinder Sachar
Registration No. 34,423

SIGNATURE

Gregory J. Maier

NAME

25,599

REGISTRATION NUMBER

DATE

April 6 2001

09/806990

205739US

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

| | |
|----------------------------|------------------------------|
| IN RE APPLICATION OF | : |
| PETER HASSE ET AL | : ATTN: APPLICATION DIVISION |
| SERIAL NO: 09/806,990 | : |
| FILED: 06 APRIL 2001 | : |
| FOR: SPARK GAP ARRANGEMENT | : |

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Prior to a first examination on the merits, please amend the above-identified application as follows:

IN THE CLAIMS

Please cancel claims 1-9 without prejudice.

Please add new claims 10-18 as follows:

10. (New) Encapsulated spark gap arrangement for use in power supply systems, in particular low-voltage systems and optimized ability to extinguish system secondary currents as well as with an arcing chamber, within which arcing occurs between two electrodes in the spark gap, wherein downstream of the arcing chamber there is disposed an intermediate chamber a volume of which is substantially larger than a volume of the arcing chamber itself, and wherein there is further provided a pressure-resistant, preferably metallic flow channel to connect the arcing chamber to the intermediate chamber.

11. (New) Encapsulated spark gap arrangement according to Claim 10, wherein the volume of the high-pressure region, including an arcing chamber and a flow channel, is related to the volume of the low-pressure region of the intermediate chamber as approximately 1:10, and a ratio between the volumes of the arcing chamber and the intermediate chamber is 1:40.

12. (New) Encapsulated spark gap arrangement according to Claim 10, wherein the intermediate chamber on its inner surface comprises metallic walls or is coated with metal layers.

13. (New) Encapsulated spark gap arrangement according to claim 10, wherein the walls of the intermediate chamber are covered on their inner surfaces with a plastic that gives off a quenching gas when heated.

14. (New) Encapsulated spark gap arrangement according to Claim 13, wherein the intermediate chamber comprises means of additional elimination of heat.

15. (New) Encapsulated spark gap arrangement according to Claim 14, wherein metallic cooling surfaces or cooling ribs are used as the means of additional elimination of heat.

16. (New) Encapsulated spark gap arrangement according to claim 10, wherein the flow channel is nozzle-shaped and has a smaller diameter than the intermediate chamber.

17. (New) Encapsulated spark gap arrangement according to claim 10, wherein the volume of the intermediate chamber is made large enough that an entire amount of gas produced by ignition in the arcing chamber is retained therein.

18. (New) Encapsulated spark gap arrangement according to claim 10,

wherein a flow channel projects into the intermediate chamber and guide means are provided therein to divert the gas flow.

IN THE ABSTRACT

Please add the following new Abstract on a separate sheet:

ABSTRACT OF THE DISCLOSURE

A spark gap arrangement for use in power systems, particularly in low-voltage systems. The spark gap arrangement includes an arcing chamber in which an electric arc is formed between two electrodes of the spark gap. An intermediate chamber is provided downstream of the arcing chamber. The intermediate chamber has a much greater volume than the arcing chamber. A pressure-proof flow channel, preferably including metal, is provided as the connection between the arcing chamber and the intermediate chamber.

REMARKS

Favorable consideration of this application, as presently amended, is respectfully requested.

The present Preliminary Amendment is submitted to place the above-identified application in more proper format under United States practice. During International Preliminary Examination, original claims 1-19, were replaced with amended claims 1-9. Accordingly, since an English translation of the annexes (containing amended claims 1-9) is being filed simultaneously herewith, claims 1-9 remain pending. By the present Preliminary Amendment claims 1-9 have been cancelled and new claims 10-18 have been presented for examination. New claims 10-18 are believed to be self-evident from the original disclosure,

including original claims 1-9, and thus are not deemed to raise any issues of new matter. A new Abstract is also submitted herein.

The present application is believed to be in condition for a full and thorough examination on the merits. An early and favorable consideration of the present application is hereby respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.



Gregory J. Maier
Attorney of Record
Registration No. 25,599
Surinder Sachar
Registration No. 34,423



22850

(703) 413-3000
Fax No.: (703) 413-2220
GJM:SNS\la
I:\atty\SNS\205739-pr.wpd

WILLIAM E. BEAUMONT
REGISTRATION NUMBER 30,996

Marked-Up Copy 09/806,990
Serial No: 20573908
Amendment Filed on:

8/16/01

IN THE CLAIMS

Claims 1-9 (Cancelled)

Claims 10-18 (Added)

IN THE ABSTRACT

Abstract (Added)

Rec'd PCT/PTO 16 AUG 2001

5

Spark gap arrangement

DESCRIPTION

The invention relates to a spark gap arrangement for use in power supply systems, in particular in low-voltage systems, comprising an arcing chamber within which an electric arc is formed between two electrodes (precharacterizing clause of Claim 1).

In efficient lightning guards capable of limiting secondary currents, such as are employed in low-voltage networks to protect against the influences of lightning flashes, the hot, ionized gases produced by the electric arc during the process of diverting the flash current are expelled with relatively high pressure, in the form of a pressure wave, through specific outlet or exhaust openings. The result is that the extreme pressure and temperature stresses generated at the spark gap by the diversion process and the associated high energy conversion are reduced sufficiently that such guards can be enclosed in small, inexpensive housings. Such spark gap arrangements are disclosed, for example, in the patent DE 196 19 334 A1 and are contained in the older, but not previously published German patent application 197 17 802. In spark gap arrangements of this kind, however, there is a danger that the expelled ionized and hence conductive gases will ignite uncontrolled interfering arcs in the immediately surrounding electric field, which can seriously reduce the usability of the system. To exclude this possibility, the manufacturers of such guards specify a safety distance relative to the guard, defining a space within which

- 2 -

no other electrical equipment may be situated. This presents the disadvantage that the often favorable, small dimensions of the guard itself do not in practice result in a saving of space. It should also be noted that the explosively expanding pressure wave that accompanies the current-diversion process must be borne by the entire surroundings of the installation (e.g., distributor housing. This requirement in particular makes it necessary to select a housing for the installation according to these criteria, and its effectiveness can be demonstrated only by tests simulating lightning flashes in a surge-current laboratory. Therefore the lightning-guard manufacturers recommend installation housings demonstrated by tests to be suitable for this purpose, which the planner/installer must use. This considerably restricts the possibilities available for a project and involves additional testing costs. Furthermore, there are several kinds of application in which the security measures mentioned above cannot be implemented (e.g., explosion protection). It is also possible that people who are too close to the exhaust opening will be endangered by the hot, ionized gases expelled from it. Devices of this kind then cannot be utilized despite the requirements for protection.

Solutions are known (e.g., DE 195 06 057 A1) that are based on hermetically encapsulated spark gaps, which are capable of extinguishing secondary currents. These avoid all the disadvantages explained above concerning the presence of outlet openings and the emergence from these openings of gases under pressure and high temperature. However, hermetically encapsulated spark gap arrangements have only a limited ability to tolerate surge currents and/or their capacity to extinguish secondary currents is inadequate for many kinds of application. They are thus not very efficient. Furthermore, such constructions require high-performance materials and place considerable demands on the mechanical and thermal stability of all structural components.

- 3 -

In contrast, the problem area and objective toward which the invention is directed is to construct a spark gap arrangement according to the precharacterizing clause of Claim 1 in such a way that the gases emerging from it do not bring about the disadvantages explained with reference to the state of the art, 5 whereas on the other hand the disadvantages of the known fully encapsulated constructions of spark gap arrangements, which have no openings to the exterior (e.g., according to DE 195 06 057 A1) are avoided.

10 To achieve this objective and solve the problem, proceeding from the precharacterizing clause of Claim 1 and in accordance with its characteristics it is first provided that downstream of the arcing chamber is disposed an intermediate (storage) chamber, the volume of which is considerably greater than the 15 volume of the arcing chamber, and that the arcing and intermediate chambers are connected to one another by a pressure-resistant, preferably metallic flow channel. The intermediate chamber receives the hot gases and decomposition products produced in the arcing chamber and stores them for 20 some time, during which the pressure wave is reduced and cooling occurs. Thereafter, the cooled and quiescent gas can either remain in the storage chamber or be released into the surroundings.

25 The released gases are thus approximately compatible with the environmental conditions, so that there is no need for safety distances, special installation housings and other measures prescribed in the state of the art. This mode of action derives in particular from the fact that the volume of the intermediate chamber is considerably larger than that of the arcing chamber, 30 so that when the gases are transferred into the intermediate chamber, their pressure is substantially decreased. The temperature of these gases is simultaneously lowered in the intermediate chamber. Furthermore, this effect is enhanced by the above-mentioned flow channel, which because of its smaller

- 4 -

cross section delays passage of the hot gases from the arcing chamber into the intermediate chamber.

The preferred embodiment of the invention according to Claim 2 is concerned with a spark gap arrangement according to Claim 1 with at least one outlet for the hot, pressurized gases formed by the arc and is characterized by the provision of one or more outlet openings or channels for the gases in the intermediate chamber. This measure facilitates the cooling of the ionized gases and degeneration of the pressure wave described above, so that the gases can leave the intermediate chamber in a directed manner, through the above-mentioned outlet openings, and harmlessly enter the surroundings.

Claim 3 states a preferred ratio of the volume of the arcing chamber to the volume of the intermediate chamber.

Subordinate claims 4 to 7 relate to possible means of enhancing the capacity of the intermediate chamber to conduct heat away and hence exert a cooling action, to which a cooling by vaporization is added if plastics that emit quenching gas are present. At the same time, because of the cooling achieved, the electrical conductivity of the emerging gases is reduced. This too is (see the above descriptions of the state of the art) an advantage.

The invention further makes it possible, by appropriate modification of certain measures, to optimize pressure and mass flow rate and temperature of the emerging gases, or to match these parameters to the requirements of the particular application. For this purpose, the possibility of influencing the mass flow rate \dot{m} is important; this quantity is determined by the ratio of the inflow cross section of the gases entering the intermediate chamber (and hence the inflowing amount of gas) to the outflow cross section during emergence from the intermediate chamber (and hence the outflowing amount of gas). Hence if the intermediate chamber is designed to have an

- 5 -

appropriate volume, the pressure wave of the emerging gases can also be influenced with respect to its amplitude and rate of rise. For example, if the outflow cross section of the gases emerging from the intermediate chamber is very much smaller

5 than the inflow cross section of the gases entering the intermediate chamber, the gases will spend a longer time within the intermediate chamber. They will be cooled by a correspondingly greater amount and not be released into the surroundings until this longer retention time has elapsed.

10 Because of this "retention effect" the enforced cooling within the intermediate chamber explained above is achieved, and it can be still further enhanced by additional heat-eliminating means (see Claims 4 to 6). In this regard care should always be taken that the volume of the high-pressure region (arcing

15 chamber and flow channel) is considerably smaller than the volume of the low-pressure region (intermediate chamber and outlets). According to the description of the above-mentioned measures and the adjustment of the mass flow rate, during the process of extinguishing secondary currents, the exhaust

20 behavior of this spark gap arrangement can be controlled.

In practice when the supply-system secondary current (short-circuit current) is interrupted, quasi-stationary flow conditions will become established within milliseconds. The intermediate chamber has only a slight influence on these flow

25 conditions. In the case of secondary-current-limiting spark gaps, with their lower passage integral and hence low power-conversion rate, it is possible to store in the intermediate chamber the entire amount of gas produced in the arcing chamber. If a sufficient pressure difference is achieved

30 between the high-pressure part and the low-pressure part, the desired gas flow does not become interrupted here, so that with such types of devices there is no need for outlet openings. During the processes associated with the diversion of lightning flashes (surge currents), which occur in the microsecond range,

35 the size of the intermediate chamber is of crucial significance, because in this situation it is not possible to

- 6 -

break down a quasi-stationary flow. In such cases the action of the invention explained above comes into play. Then the intermediate chamber must be so dimensioned with respect to its volume that it can retain the entire amount of gas explosively produced in the arcing chamber (see Claim 12). In this regard it is essential for the cross section of the inlet through which gas enters the intermediate chamber to be of such small dimensions that a kind of "nozzle congestion" occurs and the gas flow is almost completely interrupted. As a result the cooling action and hence also the energy conversion in the arc are reduced, so that relatively little pressure is developed. As a result it is possible, at least in the case of relatively small lightning currents, to do without the outlet openings in this case as well.

Further advantages and characteristics of the invention will be apparent from the other subordinate claims and from the following description and associated drawings of possible embodiments in accordance with the invention, wherein

Fig. 1: is a schematic drawing of the principle of the invention,

Figs. 2

and 3: show possible embodiments of this principle,

Figs.

4 - 6: show how the invention is embodied with a "pressure" or an "overpressure" device.

Each of the preceding drawings shows a cross section, and the arcing and intermediate chambers are not drawn to scale.

Fig. 7: shows, likewise in cross section, an embodiment intended for use in practice.

- 7 -

The spark gap arrangement 1 diagrammed in Fig. 1 consists of a one-piece housing 2 comprising an arcing chamber 3, a flow channel 4, an intermediate chamber 5 and an outlet opening or outlet channel 6. Components not relevant to understanding the invention, such as the electrodes for example, are not shown in the drawing. The flow channel 4 connects the arcing chamber 3 to the intermediate chamber 5, whereas the outlet opening or channel (more than one outlet opening or channel can also be provided) connects the intermediate chamber 5 to the external surroundings of the spark gap arrangement 1. The pressure P_1 and temperature T_1 in the arcing chamber 3 are correspondingly greater than the pressure P_2 and temperature T_2 in the intermediate chamber 5.

Although according to the invention the volume of the intermediate chamber 5 with outlet channel is substantially larger than the volume of the arcing chamber 3 with flow channel 4, to facilitate drawing of this diagram the volumes of the two chambers are not shown in the correct relation. The intermediate chamber 5 would have to be drawn larger, indicating that it is more "voluminous". The preferred ratio of the volumes of 3 and 4 to the volumes of 5 and 6 is about 1:10. The flow channel 4 can be nozzle-shaped. Furthermore, by a suitable choice of its outflow cross section 4' (D_1), through which gas enters the intermediate chamber, and of the entry cross section 6' (D_2), through which gas flows out of the intermediate chamber into the outlet channel 6, the mass flow rate \dot{m} can be influenced. If 6' is smaller than 4', a larger amount of gas can emerge through 4' and enter the intermediate chamber 5; however, at the same time the smaller cross section 6' prevents or slows emergence of the gases from the intermediate chamber.

For the purpose of cooling the gases that have entered the intermediate chamber 5, the inner surfaces 5' of its walls can be covered with a metallic coating or with a plastic that gives off quenching gas when heated. Additional means of conducting

- 8 -

heat away can also be provided here, such as cooling surfaces or ribs.

A spark gap arrangement in accordance with the invention can be made in either one piece (see the exemplary embodiments) or two. In the latter case the first piece comprises the arcing chamber 3 with flow channel 4, and the second piece consists of the intermediate chamber 5 with outlet channel 6. The two are firmly attached to one another, e.g. by screwing their housings together.

The outlet channel 6 or corresponding multiple channels can be provided with additional means for reducing the pressure and temperature of the gases. Examples (not shown in the drawing) include nozzle-shaped structures and/or additional intermediate chambers.

Another two-part embodiment is shown in Fig. 2, with a single-part housing 7 and two inserts 8 and 9, which contain the arcing chamber 3 and the flow channel 4, respectively. In this case the outlet 6 passes through the side of the housing 7.

The two-part embodiment according to Fig. 2 offers the advantage that each of the two individual parts can be exchanged for a new one when it becomes too worn.

The exemplary embodiment according to Fig. 3 is similar to that in Fig. 2, so that the reference numerals 7, 8 and 9 are used again here. Here, however, the above-mentioned principle of "evaporative cooling" is implemented by providing the inner surface of the intermediate chamber 5 with a lining 10 made of a plastic (POM) that releases gas. Alternatively, a metallic lining or encapsulation of the interior of the chamber 5 could be provided. These two variants, namely lining with either a gas-releasing plastic or a metal coating or capsule, can also be combined in one and the same spark gap arrangement. This depends on the requirements of the particular practical

- 9 -

application. Capsules of plastic or ceramic would also be possible.

Fig. 3 further shows that the flow channel 4 is elongated so as to project into the intermediate chamber 5, as indicated by 4", and there terminates in lateral openings 11 that direct the hot gases into the chamber toward the left and right as well as upward and downward, until the gases pass through a transverse bore 12 into the outlet channel 6. This guidance of the gases over longer pathways (so-called "detours") also contributes to cooling and depressurizing the gases.

Finally, emergence of the gases can be controlled by blocking means of the nature of pressure control valves. For instance, Fig. 4 shows a ball 13 that is pressed upward under the action of a spring 14. As indicated by numeral 15, the gases contained in the intermediate chamber 5 press against the ball from above. Once the pressure of the gases has passed a certain level, the ball is forced downward against the action of the compression spring 14, so that the gases can flow out as indicated by numerals 16. The spring force 14 is adjusted so that a maximal loading must be reached, i.e. a critical threshold passed, before the ball 13 gives way and allows the gases free passage from 15 to 16, so that the exhaust process can take place. As a result, the exhaust process would occur only in rare cases, e.g. in the presence of an extremely large lightning or short-circuit current. In the case of smaller surge currents, or during the interruption of small system secondary currents, the entire amount of gas produced in the arcing chamber would remain in the intermediate chamber. From this it is also evident that the outlet openings or channels explained above need not necessarily be present, but are required only in cases in which the gases formed in the arcing chamber cannot be completely retained and cooled within the intermediate chamber.

- 10 -

Furthermore, the exhaust pressure, e.g. such as is used to open a pressure control valve as described above, can also serve as an indicator of a pressure load, e.g. to signal the presence of a defect, in which case the operator of the system can respond by initiating specified measures or can at least check the guard and its relevant parts. Such signals are shown in the embodiments of Figs. 5 and 6. In the case of Fig. 5 the generation of pressure by the arc is to be used to record or count a response of the spark gap. For this purpose a membrane 17 is provided which, when the pressure 15 of the gases contained in the intermediate chamber 5 reaches a limiting value, is bent downward (see the dashed line 17') and thereby closes a switch 18 and hence sends a corresponding signal. This can also be a signal representing the state of the guard. When a load limit is exceeded, this signal can be used to turn off the guard system. It is also possible for a central evaluation device to be included in the circuit.

In the exemplary embodiment of Fig. 6 the pressure generated by the arc is to be used in such a way that when a specified pressure value is reached, the pressure is relieved and also a corresponding signal is sent. For this purpose the ball 13 is replaced by a functionally equivalent cone-shaped sealing element 19, which under the action of springs 20 at first blocks the gas-flow path 15/16, but when the pressure indicated by numeral 15 becomes large enough to displace the cone 19 downward against the action of the springs 20, the gas can flow out. When the cone 19 has descended far enough, a switch plate 21 comes to rest on two contacts 22. As a result, the circuit of a signalling system is closed so that the appropriate message is sent. However, this applies to only a small proportion of the cases that arise in practice; for 80-90% of the overload currents that actually occur, in particular system secondary currents, the overpressure valve will remain in the closed position.

- 11 -

The embodiment according to Fig. 7 consists of a pressure-resistant housing 23 that comprises a floor part 24 and a head part 25 at its end face. Here, again, there are provided an arcing chamber 3, a flow channel 4, an intermediate chamber 5 and routes 11, 12 along which the gases entering from the channel 4 pass before emerging at 6. In this case, for the sake of structural simplification, the flow channel 4 has the same diameter as the arcing chamber 3.

All the characteristics represented and described here, as well as their combinations with one another, are essential to the invention.

10
403429-06500000

New Claims

- 5 1. Encapsulated spark gap arrangement for use in power supply systems, in particular low-voltage systems and optimized ability to extinguish system secondary currents as well as with an arcing chamber, within which arcing occurs between two electrodes in the spark gap, wherein downstream of the arcing chamber there is disposed an intermediate chamber the volume of which is substantially larger than the volume of the arcing chamber itself, and wherein there is further provided a pressure-resistant, preferably metallic flow channel to connect the arcing chamber to the intermediate chamber.
- 10 2. Encapsulated spark gap arrangement according to Claim 1, characterized in that the volume of the high-pressure region, consisting of arcing chamber and flow channel, is related to the volume of the low-pressure region of the intermediate chamber as approximately 1:10, and the ratio between the
- 15 20 volumes of the arcing chamber and the intermediate chamber is 1:40.
3. Encapsulated spark gap arrangement according to Claim 1 or 2, characterized in that the intermediate chamber (5) on its inner
- 25 surface comprises metallic walls or is coated with metal layers.
4. Encapsulated spark gap arrangement according to one or more of the claims 1 to 3, characterized in that the walls of the intermediate chamber (5)
- 30 are covered on their inner surfaces with a plastic (10) that gives off a quenching gas when heated.

- 13 -

5. Encapsulated spark gap arrangement according to Claim 4, characterized in that the intermediate chamber (5) comprises means af additional elimination of heat.

5 6. Encapsulated spark gap arrangement according to Claim 5, characterized by metallic cooling surfaces or cooling ribs as a means of additional elimination of heat.

10 7. Encapsulated spark gap arrangement according to one or more of the claims 1 to 6, characterized in that the flow channel (4) is nozzle-shaped and has a smaller diameter than the intermediate chamber.

15 8. Encapsulated spark gap arrangement according to one or more of the claims 1 to 7, characterized in that the volume of the intermediate chamber (5) is made large enough that the entire amount of gas produced by ignition in the arcing chamber (3) is retained therein.

20 9. Encapsulated spark gap arrangement according to one or more of the claims 1 to 8, characterized in that the flow channel projects into the intermediate chamber (5) and guide means (11) are provided therein to divert the gas flow.

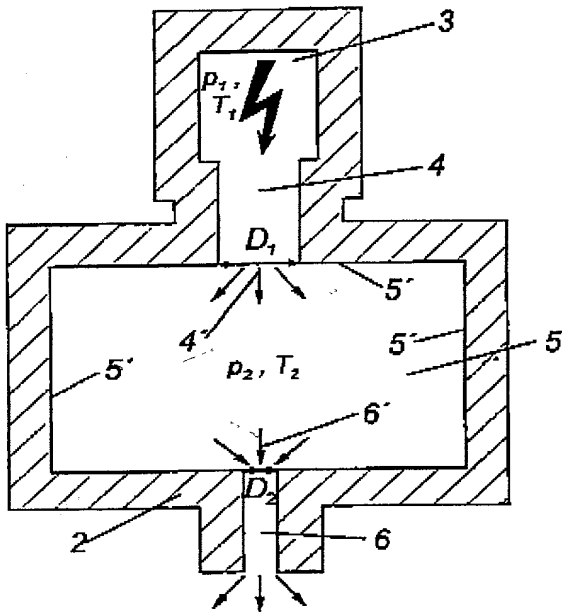


Fig. 1

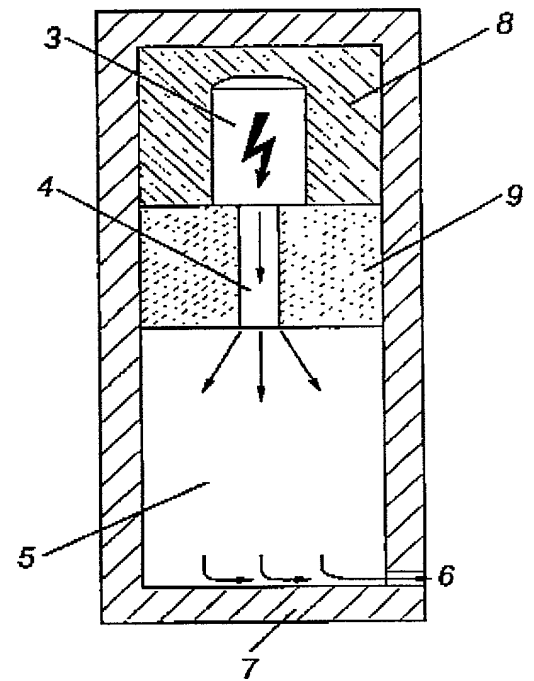


Fig. 2

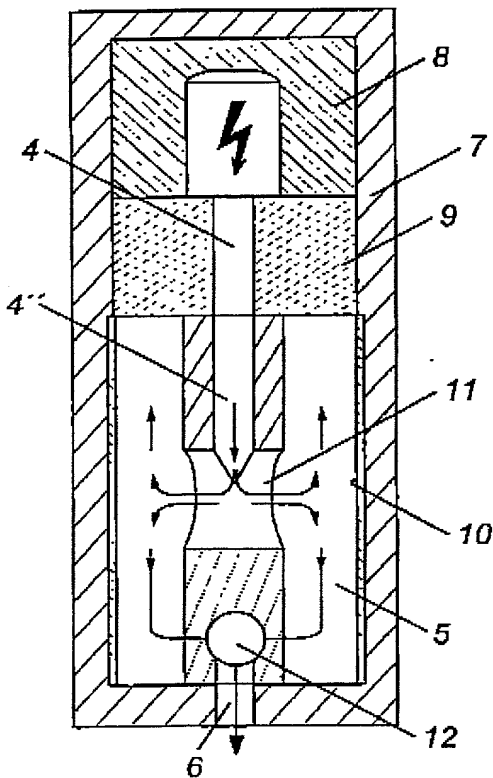


Fig. 3

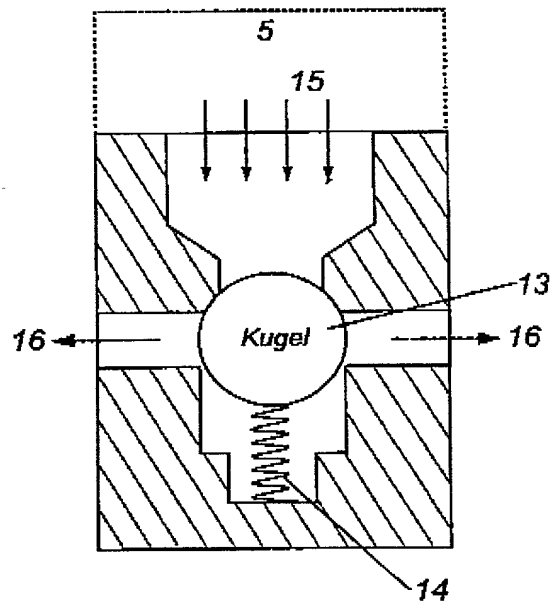


Fig. 4

205139us6Pat

213

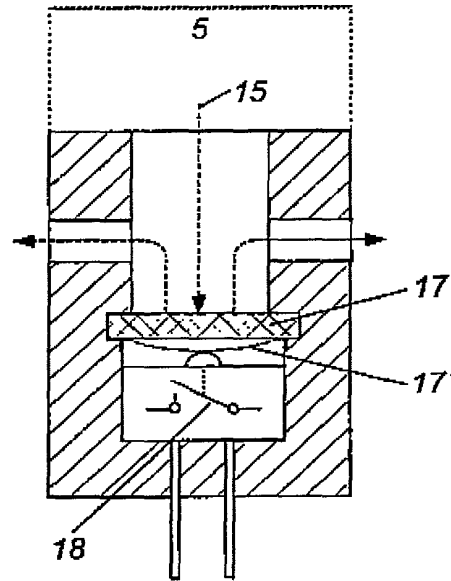


Fig. 5

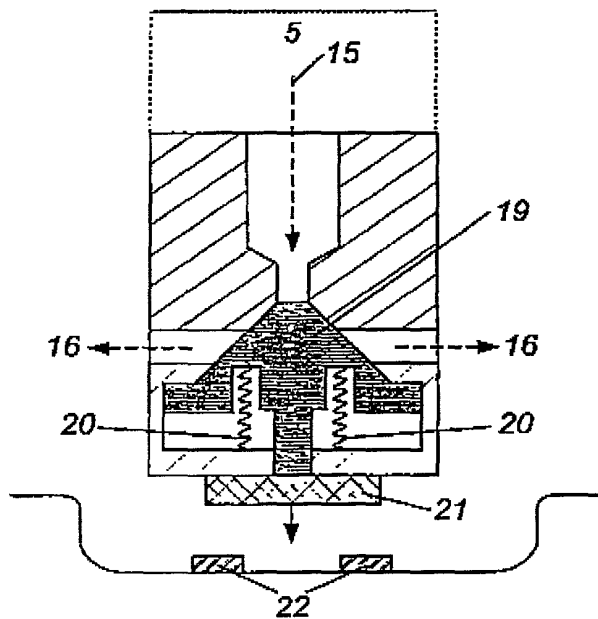


Fig. 6

09806990.001001

2057394.56 for
3/3

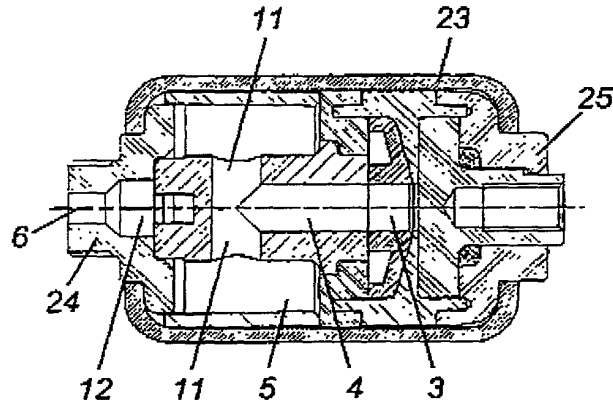


Fig. 7

09806990-001601

Declaration and Power of Attorney for Patent Application

Erklärung für Patentanmeldungen mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

daß mein Wohnsitz, meine Postanschrift und meine Staatsangehörigkeit den im nachstehenden nach meinem Namen aufgeführten Angaben entsprechen, daß ich nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent für die Erfindung mit folgendem Titel beantragt wird

deren Beschreibung:

ist beigefügt

☐ wurde angemeldet am _____

unter der US-Anmeldenummer oder unter der Internationalen Anmeldenummer im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT)

_____ und am

_____ abgeändert (falls zutreffend).

Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Patentanmeldung, einschließlich der Ansprüche, die eventuell durch einen oben erwähnten Zusatzantrag abgeändert wurde, durchgesehen und verstanden habe

Ich erkenne meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Titel 37, Code of Federal Regulations, § 1.56 von Belang sind

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

SPARK GAP ARRANGEMENT

the specification of which:

☐ is attached hereto.

☒ was filed on 06 April 2001

as United States Application Number or PCT International Application Number

_____ and was amended on

_____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

German Language Declaration

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäß
 Title 35, US-Code, § 119(a)-(d), bzw. § 365(b) aller unten
 aufgeführten Auslandsanmeldungen für Patente oder
 Erfinderurkunden, oder § 365(a) aller PCT internationalen
 Anmeldungen, welche wenigstens ein Land ausser den
 Vereinigten Staaten von Amerika benennen, und habe
 nachstehend durch ankreuzen sämtliche Auslandsanmeldungen
 für Patente bzw. Erfinderurkunden oder PCT internationale
 Anmeldungen angegeben, deren Anmeldetag dem der
 Anmeldung, für welche Priorität beansprucht wird, vorangeht

I hereby claim foreign priority under Title 35, United States Code, § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below, and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior foreign application(s)
(Frühere ausländische Anmeldungen)

Priority claimed

Priorität
beansprucht

| | |
|--------------|-----------|
| 198 45 889.4 | GERMANY |
| (Number) | (Country) |
| (Nummer) | (Land) |

06 October 1998
(Day/Month/Year Filed)
(Tag/Monat/Jahr der Anmeldung)

☒ Yes
Ja

☐ No
Nein

| | |
|----------|-----------|
| (Number) | (Country) |
| (Nummer) | (Land) |

(Day/Month/Year Filed)
(Tag/Monat/Jahr der Anmeldung)

☐ Yes
Ja

☐ No
Nein

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below

(Application No.)
(Aktenzeichen)

(Filing Date)
(Anmeldetag)

(Application No.)
(Aktenzeichen)

(Filing Date)
(Anmeldetag)

Ich beanspruche hiermit die mir unter Title 35, US-Code, § 120 zustehenden Vorteile aller unten aufgeführten US-Patentanmeldungen bzw. § 365(c) aller PCT internationalen Anmeldungen, welche die Vereinigten Staaten von Amerika benennen, und erkenne, insofern der Gegenstand eines jeden früheren Anspruchs dieser Patentanmeldung nicht in einer US-Patentanmeldung, bzw. PCT internationalen Anmeldung in in einer gemäß dem ersten Absatz von Title 35, US-Code, § 112 vorgeschriebenen Art und Weise offenbart wurde, meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Title 37, Code of Federal Regulations, § 1.56 von Belang sind und die im Zeitraum zwischen dem Anmeldetag der früheren Patentanmeldung und dem nationalen oder im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT) gültigen internationalen Anmeldetags bekannt geworden sind

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

PCT/EP99/06962

(Application No.)
(Aktenzeichen)

21 September 1999

(Filing Date)
(Anmeldetag)

(Status) (patented, pending, abandoned)
(Status) (patentiert, schwebend, aufgegeben)

(Application No.)
(Aktenzeichen)

(Filing Date)
(Anmeldetag)

(Status) (patented, pending, abandoned)
(Status) (patentiert, schwebend, aufgegeben)

Ich erkläre hiermit, daß alle in der vorliegenden Erklärung von mir gemachten Angaben nach bestem Wissen und Gewissen der Wahrheit entsprechen, und ferner daß ich diese erdesstattliche Erklärung in Kenntnis dessen ablege, daß wissentlich und vorsätzlich falsche Angaben oder dergleichen gemäß § 1001, Titel 18 des US-Code strafbar sind und mit Geldstrafe und/oder Gefängnis bestraft werden können und daß derartige wissentlich und vorsätzlich falsche Angaben die Rechtswirksamkeit der vorliegenden Patentanmeldung oder eines aufgrund deren erteilten Patentes gefährden können

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

VERTRETUNGSVOLLMACHT. Als benannter Erfinder beauftrage ich hiermit den (die) nachstehend aufgeführten Patentanwalt (Patentanwälte) und/oder Vertreter mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Angelegenheiten vor dem US-Patent- und Markenamt: (Name(n) und Registrationsnummer(n) auflisten)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)

Norman F. Oblon, Reg. No. 24,618; Marvin J. Spivak, Reg. No. 24,913; C. Irvin McClelland, Reg. No. 21,124; Gregory J. Maier, Reg. No. 25,599; Arthur I. Neustadt, Reg. No. 24,854; Richard D. Kelly, Reg. No. 27,757; James D. Hamilton, Reg. No. 28,421; Eckhard H. Kuesters, Reg. No. 28,870; Robert T. Pous, Reg. No. 29,099; Charles L. Gholz, Reg. No. 26,395; William E. Beaumont, Reg. No. 30,996; Jean-Paul Lavalleye, Reg. No. 31,451; Stephen G. Baxter, Reg. No. 32,884; Richard L. Treanor, Reg. No. 36,379; Steven P. Weihrauch, Reg. No. 32,829; John T. Goolkasian, Reg. No. 26,142; Richard L. Chinn, Reg. No. 34,305; Steven E. Lipman, Reg. No. 30,011; Carl E. Schlier, Reg. No. 34,426; James J. Kulbaski, Reg. No. 34,648; Richard A. Neifeld, Reg. No. 35,299; J. Derek Mason, Reg. No. 35,270; Surinder Sachar, Reg. No. 34,423; Christina M. Gadiano, Reg. No. 37,628; Jeffrey B. McIntyre, Reg. No. 36,867; William T. Enos, Reg. No. 33,128; Michael E. McCabe, Jr., Reg. No. 37,182; Bradley D. Lytle, Reg. No. 40,073; and Michael R. Casey, Reg. No. 40,294, with full powers of substitution and revocation.

Postanschrift:

Send Correspondence to:

OBLON, SPIVAK, MCCLELLAND, MAIER & NEUSTADT, P.C.
FOURTH FLOOR
1755 JEFFERSON DAVIS HIGHWAY
ARLINGTON, VIRGINIA 22202 U S A

Telefonische Auskünfte.
(Name und Telefonnummer)

Direct Telephone calls to: (name and telephone number)

(703) 413-3000

| | | | |
|---|-------|--|--|
| Vor- und Zuname des einzigen oder ersten Erfinders | 1-00 | Full name of sole or first inventor | <u>Peter HASSE</u> |
| Unterschrift des Erfinders | Datum | Inventor's signature | Date |
| Wohnsitz | | Residence | <u>Roggenstrasse 1, D-92318 Neumarkt GERMANY</u> |
| Staatsangehörigkeit | | Citizenship | <u>GERMANY</u> |
| Postanschrift | | Post Office Address | <u>same as above</u> |
| Vor- und Zuname des zweiten Miterfinders (falls zutreffend) | 2-00 | Full name of second joint inventor, if any | <u>Peter ZAHLMANN</u> |
| Unterschrift des zweiten Erfinders | Datum | Second inventor's signature | Date |
| Wohnsitz | | Residence | <u>Johann-Mois-Ring 15 A, D-92318 Neumarkt GERMANY</u> |
| Staatsangehörigkeit | | Citizenship | <u>GERMANY</u> |
| Postanschrift | | Post Office Address | <u>same as above</u> |

(Im Falle dritter und weiterer Miterfinder sind die entsprechenden Informationen und Unterschriften hinzuzufügen.)

(Supply similar information and signature for third and subsequent joint inventors.)

German Language Declaration

| | | | |
|--|---|-----------------------------|---------------------|
| Vor- und Zuname des dritten Miterfinders (falls Zutreffend) | Full name of third joint inventor, if any | | |
| | <u>Raimund KOENIG</u> | | <u>3-00</u> |
| Unterschrift des dritten Erfinders | Datum | Third inventor's signature | Date |
| | | <u>[Signature]</u> | <u>19 June 2001</u> |
| Wohnsitz | Residence <u>Gartenstrasse 5, D-92369 Sengenthal GERMANY</u> | | |
| Staatsangehörigkeit | Citizenship <u>GERMANY</u> | | |
| Postanschrift | Post Office Address <u>same as above</u> | | |
| | | | |
| Vor- und Zuname des vierten Miterfinders (falls Zutreffend) | Full name of fourth joint inventor, if any | | |
| | <u>Georg WITTMANN</u> | | <u>4-00</u> |
| Unterschrift des vierten Erfinders | Datum | Fourth inventor's signature | Date |
| | | <u>[Signature]</u> | <u>19 June 2001</u> |
| Wohnsitz | Residence <u>Lauterachstrasse 17, D-92283 Lauterhofen GERMANY</u> | | |
| Staatsangehörigkeit | Citizenship <u>GERMANY</u> | | |
| Postanschrift | Post Office Address <u>same as above</u> | | |
| | | | |
| Vor- und Zuname des fünften Miterfinders (falls Zutreffend) | Full name of fifth joint inventor, if any | | |
| Unterschrift des fünften Erfinders | Datum | Fifth inventor's signature | Date |
| Wohnsitz | Residence | | |
| Staatsangehörigkeit | Citizenship | | |
| Postanschrift | Post Office Address | | |
| | | | |
| Vor- und Zuname des sechsten Miterfinders (falls Zutreffend) | Full name of sixth joint inventor, if any | | |
| Unterschrift des sechsten Erfinders | Datum | Sixth inventor's signature | Date |
| Wohnsitz | Residence | | |
| Staatsangehörigkeit | Citizenship | | |
| Postanschrift | Post Office Address | | |
| | | | |

(Im Falle dritter und weiterer Miterfinder sind die entsprechenden Informationen und Unterschriften hinzuzufügen.)

(Supply similar information and signature for third and subsequent joint inventors.)